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Spacing Studies with Asparagus

H. A. JONES

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SPACING STUDIES WITH ASPARAGUS

H. A. JONES[1]

INTRODUCTION

Spacing experiments with the Palmetto variety of asparagus have been conducted at Davis, California, since 1924. These studies were begun to determine the effect of different planting distances on yield, size of spear, and longevity of the bed. Although this project will probably be continued for another six or seven years, certain results already obtained are of considerable practical interest and may well be reported at this time.

The crowns for these studies were grown in a nursery at the University Farm in 1923. They were dug in February, 1924, and within a few days were set in furrows 8 inches deep, 7½ feet apart and 236½ feet long. The rows were run east and west. The distance between rows remained constant, but in the rows spacings of 12, 18, 30, and 36 inches were used. Guard rows were not used between the different spacings. All of the different spacings were in duplicate and all data in the following tables are averages of the two plots. The soil is a Yolo silt loam.

During the summer, the field was surface-irrigated whenever necessary. The time of the first irrigation each year varied somewhat with the amount of winter rainfall. A heavy irrigation was always given immediately after the cutting season. The last application was usually given about the first of September.

The tops were cut each year about the middle of October, allowed to dry, and burned. About 15 tons of barnyard manure was applied per acre each fall, and then plowed or disked under. Ridges of soil were thrown over the rows to facilitate the rotting of the stubble during the winter and were left until the field was prepared for the harvesting season; then they were disked down and low ones rebuilt to mark the rows for the cutters and to facilitate irrigation.

The tests were conducted with plants of both sexes, the males and females of the same spacing being planted in separate rows side by side with one male row and one female row in each plot. The males and females were planted separately in order to obtain a

[1] Professor of Truck Crops and Olericulturist in the Experiment Station.

distinct record of each sex. The data on the differences between the two sexes is being reported in another paper. In this bulletin the data for the male and female plants of the same spacing have been combined. Although the sexes were not intermingled as in the commercial fields it is doubtful if this fact is significant, because when the data were analyzed separately the different sexes were found to respond in about the same way to differences in spacing.

THE PRODUCTION OF SPEARS

The plots were cut for the first time in the spring of 1925, the year following planting. From year to year the date of the first cutting varied somewhat with climatic conditions; but it was usually in late February or early March. The last cutting for the season in 1925 was made on April 1; in 1926 on April 25; in 1927 and 1928 on May 15; and in 1929, 1930, and 1931, on May 20.

TABLE 1

AVERAGE NUMBER OF SPEARS PER PLANT

Spacing, inches	1925	1926	1927	1928	1929	1930	1931
12	2.09	9.43	13.16	15.66	17.62	22.30	31.28
18	2.57	11.95	17.75	21.23	24.36	31.31	44.16
30	2.90	14.49	23.18	29.89	35.63	46.75	66.92
36	2.82	14.88	24.23	31.88	37.76	49.25	70.89

The plots were harvested once each day throughout the cutting season, only those spears being cut that were 7½ inches or more above the ground. All spears were cut long enough to be trimmed to a uniform length of 8½ inches. Immediately after being harvested, they were counted, trimmed, and weighed so that all yield records in the tables are for spears cut green and trimmed to a length of 8½ inches. Spears too spindling to be included in the usual small grade of the fresh pack were cut and left lying in the field.

Average Number of Spears per Plant.—The average number of spears produced per plant each year appears in table 1. It increased from year to year at all the different spacings, but most rapidly at the wider spacings. The crowding effect of the 12 and 18-inch spacings was evident from the first cutting season. It is difficult to understand why the effect of close planting should appear so early in the life of the bed. During the seven-year period the plants spaced

30 inches apart produced approximately twice as many spears as those 12 inches apart. The data in column 2 of table 6 show the differences in the average number of spears produced per plant at the different spacings.

Average Weight of Spears.—Table 2 gives the average weight of spears, which increased each year up to 1929, the fifth cutting season. After that time the weight declined, regardless of the spacing distance. The latter fact was somewhat surprising, for the plants spaced 30 to 36 inches apart had been expected to maintain the production of large

TABLE 2

Average Weight of Spears in Grams

Spacing, inches	1925	1926	1927	1928	1929	1930	1931
12	18.73	22.80	26.32	27.93	29.33	26.43	27.03
18	20.48	26.07	29.65	32.02	32.28	28.62	28.27
30	21.67	26.91	29.25	30.53	31.27	27.62	26.90
36	21.46	27.33	29.86	31.30	32.97	28.68	28.54

spears over a longer period of time than those spaced closer. These data show that after a certain time in the life of a plant the spears are smaller even under conditions extremely favorable for growth—a fact rather discouraging to growers who wish to rejuvenate beds in mid-life in order to maintain the production of large spears. Possibly under different conditions of soil and climate, the decrease in the average weight per spear would begin at a different time in the life of the bed.

The data in column 3 of table 6 show that the average weight of the spears at the 12-inch spacing was significantly less than at the wider spacings. There was no significant difference in the weight of the spears from plants spaced 18 to 36 inches apart, a fact somewhat surprising because one would naturally expect a fairly regular increase in the average weight per spear as the distance between plants was increased.

Size Grades.—Each day throughout the cutting season during the three years 1929 to 1931, the spears were graded to determine the distribution of sizes at the different spacings. The diameter was measured 5½ inches from the tip of the spear. The five grades used and the percentage of spears by weight that occur in the different grades are given in table 3. In all the different spacings there was a decided increase in the percentage of the smaller grades and a decrease

in the percentage of the larger grades from 1929 to 1931. The highest percentage of the smallest grade, for any one year, always occurred at the 12-inch spacing. The trend of these data and observations on commercial beds indicate that this increase in the percentage of smaller sizes will probably continue during the remaining life of the bed. One can obtain the yield per acre of the different grades by multiplying the yield figures in table 5 by the percentage figures in table 3.

TABLE 3

PERCENTAGES OF SPEARS BY WEIGHT THAT OCCUR IN DIFFERENT SIZE GRADES BASED ON DIAMETER*

Spacing, inches	Year	Under ⅜ inch	⅜ to ½ inch	½ to ⅝ inch	⅝ to ¾ inch	Over ¾ inch
12	1929	4.92	19.11	30.84	30.53	14.60
	1930	5.96	29.05	32.76	22.97	9.25
	1931	10.00	30.47	32.39	20.37	6.77
18	1929	2.81	14.28	30.78	34.49	17.64
	1930	3.74	23.24	35.00	28.00	10.01
	1931	8.27	29.02	33.70	21.31	7.70
30	1929	3.02	16.13	32.30	33.97	14.58
	1930	4.53	24.94	36.17	26.66	7.70
	1931	8.25	33.01	33.78	19.68	5.28
36	1929	2.38	14.75	31.20	33.73	17.94
	1930	4.07	24.12	32.79	28.01	11.01
	1931	6.25	29.60	33.84	22.18	8.13

* The diameter of spears was measured 5½ inches from the tip.

Average Weight of Spears per Plant.—The average yield of spears per plant is given in table 4. It increased, at all spacings, from year to

TABLE 4

AVERAGE WEIGHT OF SPEARS PER PLANT IN GRAMS

Spacing, inches	1925	1926	1927	1928	1929	1930	1931
12	39	215	346	438	517	590	846
18	53	312	526	680	786	896	1,249
30	63	390	678	913	1,114	1,291	1,800
36	61	407	724	998	1,245	1,413	2,023

year during the seven cutting seasons; but the rate of increase was much more rapid at the wider spacings. The data in column 4 of table 6 show the differences in the average weight of spears per plant for the different spacings. With each increase in spacing there was a significant increase in the weight of spears produced per plant.

Possibly, even at the 36-inch spacing, the maximum yield per plant has not been attained. From the grower's standpoint, however, the yield per acre is usually the most important consideration; not the yield per plant.

Average Yield of Spears per Acre.—Table 5 gives the average yield of spears per acre, which increased for all spacings during the

TABLE 5

Average Yield of Spears in Pounds per Acre

Spacing, inches	1925	1926	1927	1928	1929	1930	1931	Total
12	492	2,711	4,361	5,508	6,506	7,424	10,646	37,648
18	437	2,670	4,368	5,643	6,524	7,437	10,362	37,441
30	317	1,964	3,414	4,595	5,611	6,502	9,063	31,466
36	259	1,735	3,085	4,255	5,308	6,023	8,761	29,426

seven cutting seasons. The increase in yield per acre during the first five cutting seasons was caused by an increase in both the number and size of spears produced; the increase during the sixth and seventh cutting seasons, however, was caused entirely by the increase in the number of spears produced per acre. The yield per acre of the

Fig. 1.—Irrigating asparagus plots at Davis, shortly after the crowns were set. Photograph taken March 14, 1924.

18-inch spacing was almost the same as that of the 12-inch for the seven-year period. Even after seven years the plants spaced 30 and 36 inches apart had not caught up in yield per acre with those spaced 12 and 18 inches. Later in the life of the bed, perhaps, the yields at the wider spacings will reach or surpass those of the closer spacings. Even though this should occur, it would seem that the most profitable

practice would be to use the spacing that gives the maximum yields during the early life of the bed. The 18-inch spacing appears to have been the best during the seven cutting seasons because it surpasses the 12-inch spacing in size of spear, and the wider spacings in yield per acre. The plants at this spacing have maintained the yield per acre of the close spacing and the average size per spear of the wider spacings.

Although the wider spacings (30 and 36-inch) gave a higher yield of spears per plant, the yield per acre decreased because the increased production per plant did not compensate for the smaller number of plants per acre.

TABLE 6

COMPARISON OF SPEAR PRODUCTION OF PLANTS AT DIFFERENT SPACINGS[2]

1 Spacings compared (inches)	2 Difference in number of spears per plant	3 Difference in weight of single spear (grams)	4 Difference in weight of spears per plant (grams)	5 Difference in yield per acre (pounds)
18–12	5.97*	2.68*	216*	–30†
30–18	9.49*	–0.46†	250*	–854*
36–30	1.71†	0.85†	89*	–291†

* Differences are considered significant.
† Differences are not considered significant.

In these spacing studies, the distance between rows approximates that used by most of the growers in the Delta region where the production of white asparagus for canning makes it necessary to have rows far apart in order that soil may be available for making the ridges. Where only green asparagus is desired for canning or for market the rows can be planted somewhat closer together as only a low ridge of soil is needed over the row to mark it and to facilitate irrigation. If rows were planted somewhat closer together than was done in these tests and with an 18-inch spacing in the row one would expect an increase in the yield per acre with little or no decrease in the average weight per spear.

[2] The data in tables 6 and 11 are the result of analysis using Love's modification of Student's method[3] to determine whether the differences obtained are significant. In column 2 of the above table, 5.97 is obtained by subtracting the average number of spears at the 12-inch spacing from the average number of spears at the 18-inch spacing. The number is positive and means that an average of 5.97 more spears were produced per plant per year at the 18 than at the 12-inch spacing. In column 5 the number 30 is negative and means that 30 pounds less spears were produced per acre per year at the 18 than at the 12-inch spacing.

[3] Love, H. H. A modification of Student's table for use in interpreting experimental results. Jour. Amer. Soc. Agron. **16**:68–73. 1924.

THE PRODUCTION OF STALKS

In addition to a record of spear production from the different spacings, a record was also kept of the weight and number of stalks produced. Each year, the stalks were counted, cut, and weighed before the first killing frost. The stalks were always weighed immediately after cutting and all of the different spacings were cut and weighed at the same time. Although they could not be harvested at the same stage of maturity from year to year, an attempt was made to weigh them while they were still green and before the foliage began to fall. While it is probably not a good commercial practice to cut

Fig. 2.—The stalks were cut with a mowing machine and then gathered and weighed immediately. The weighing is being done at the far end of the field. Photograph taken October 17, 1925.

the stalks green, it was the only means by which comparative weights of the different spacings could be obtained. In 1931 the stalks were counted but not weighed.

Number of Stalks Produced per Plant.—The average number of stalks produced per plant is given in table 7. The number varied considerably from year to year, but the fewest were always produced at the 12-inch spacing. Even in 1924, the year the bed was planted, the number of stalks produced at the 12-inch spacing was significantly less than at the wider spacings. Except at the 36-inch spacing, the fewest stalks per plant were produced in 1925, the year the spears were cut for the first time. After 1925, a gradual but somewhat

irregular increase occurred. The data in column 2 of table 11 show that there was a significant increase in the number of stalks produced per plant with each increase in spacing.

TABLE 7

AVERAGE NUMBER OF STALKS PER PLANT

Spacing, inches	1924	1925	1926	1927	1928	1929	1930	1931
12	6.20	4.30	4.49	5.59	6.17	8.11	6.73	8.14
18	8.00	6.35	5.81	7.86	8.30	9.98	9.69	12.17
30	8.55	8.09	8.23	11.95	12.41	15 99	14.70	18.49
36	8.57	9.92	8.96	10.92	14.22	16.89	17.54	19.25

Average Weight per Stalk.—The average weight per stalk is given in table 8. The year the bed was planted, the average weight per stalk was very light. The first few stalks that appeared after the crowns were set were much smaller than those produced later in the season. The second year, the average weight per stalk was about three to four times that of the first year. The average weights fluctuated considerably from year to year between 1925 and 1930, but the highest

TABLE 8

AVERAGE WEIGHT PER STALK IN POUNDS

Spacing, inches	1924	1925	1926	1927	1928	1929	1930
12	0.088	0.397	0.385	0.375	0.373	0.389	0.429
18	0.104	0.412	0.446	0.391	0.413	0.503	0.479
30	0.117	0.394	0.441	0.362	0.391	0.461	0.427
36	0.119	0.304	0.416	0.443	0.387	0.490	0.419

average weight per stalk for the three widest spacings was obtained in 1929, the year in which the average weight per spear was also highest. The data in column 3 of table 11 show that the weight per stalk was significantly less at the 12-inch than at the wider spacings, and that there was no significant difference in the weight per stalk from plants spaced 18 to 36 inches apart. It has already been shown in this paper that there was no significant difference in weight per spear between the three wider spacings, and that at the 12-inch spacing the spears were significantly smaller. The different spacings have about the same effect on the size of stalk as on the size of spears.

TABLE 9

Average Weight of Stalks per Plant in Pounds

Spacing, inches	1924	1925	1926	1927	1928	1929	1930
12	0.55	1.71	1.73	2.10	2.31	3.16	2.89
18	0.83	2.61	2.59	3.08	3.43	5.02	4.64
30	1.00	3.19	3.63	4.33	4.84	7.37	6.28
36	1.01	3.02	3.73	4.84	5.50	8.28	7.36

TABLE 10

Weight of Stalks in Pounds per Acre

Spacing, inches	1924	1925	1926	1927	1928	1929	1930
12	3,113	9,750	9,891	11,966	13,182	18,020	16,515
18	3,119	9,854	9,762	11,592	12,911	18,922	17,467
30	2,284	7,288	8,295	9,891	11,070	16,841	14,354
36	1,965	5,845	7,220	9,369	10,646	16,018	14,244

TABLE 11

Comparison of Stalk Production of Plants at Different Spacings

1 Spacings compared (inches)	2 Difference in number of stalks per plant	3 Difference in weight of single stalk (pounds)	4 Difference in weight of stalks per plant (pounds)	5 Difference in weight of stalks per acre (pounds)
18–12	2.30*	0.044*	1.10*	170†
30–18	3.78*	–0.022†	1.20*	–1943*
36–30	0.98*	–0.002†	0.44†	–674*

* Differences are considered significant.

† Differences are not considered significant.

Average Weight of Stalks per Plant.—The average weight of stalks per plant is given in table 9. Although it was rather light the first year when compared with the second year, the growth obtained was somewhat heavier than on the average commercial plantation the first year. An increase occurred in the average weight of green stalks per plant from year to year, the weight per plant increasing with the spacing distance—a relation shown also for the yield of spears per plant (table 4). There was very little difference in the weight of stalks per plant between the 30 and 36-inch spacings during the first three years, but thereafter the difference in favor of the 36-inch spacing increased annually. The data in column 4 of table 11 give the differences in the weight of stalks per plant between the different spacings.

Weight of Stalks per Acre.—The weight of stalks per acre, given in table 10, differed very little between the 12 and 18-inch spacings, but it gradually decreased as the spacings were increased beyond 18 inches. It will be recalled that these same relations held for spear production. The increase in weight of stalks per plant at the wider spacings did not compensate for the decrease in the number of plants per acre.

SUMMARY

Spears.—The average number of spears produced per plant increased from year to year at all the spacings. The number also increased with each increase in the spacing distance.

The average weight per spear at the 12-inch spacing was significantly less than at the wider spacings. No significant difference appeared in the average weight of the spears in plants set 18, 30, and 36 inches apart. At all spacings the average weight per spear increased to the fifth cutting season, after which there was a decline.

The average weight of spears produced per plant increased from year to year during the seven cutting seasons. The yield per plant increased with the spacing distance.

The yield of spears per acre increased from year to year during the seven cutting seasons. No significant difference in yield per acre appeared in plants set 12 and 18 inches apart. The yield gradually decreased, however, as the plants were set farther apart, because the increase in yield per plant did not compensate for the decrease in number of plants per acre.

Stalks.—The average number of stalks produced per plant increased with the planting distance. Disregarding the data for the first year, the number of stalks produced per plant at all planting distances gradually increased from year to year. There was also an increase in number with each increase in spacing distance.

The average weight per stalk at the 12-inch spacing was significantly lower than at the wider spacings. The average weight per stalk of plants set 18, 30, and 36 inches apart showed no significant difference.

The average weight of stalks produced per plant increased from year to year during the seven years. The weight also increased with each increase in the spacing distance.

The weight of stalks produced per acre increased from year to year during the seven years. Although no significant difference appeared in the weight of stalks produced per acre at the 12 and 18-inch spacings, the yield at the wider spacings decreased because the increase in the yield per plant did not compensate for the decrease in number of plants per acre.

To recapitulate: Experiments extending over a period of seven years with four different planting distances show that plants spaced about 18 inches apart in the row gave the best results. The 18-inch spacing was superior to the 12-inch spacing in size of spear and superior to the wider spacings in yield per acre. The plants at the 18-inch spacing have maintained the yield per acre of the closer spacing and the average size per spear of the wider spacings. These data apply to asparagus cut green, with a distance of 7½ feet between rows, at Davis, California.

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305. Liming the Soil.
307. American Foulbrood and Its Control.
308. Cantaloupe Production in California.
310. The Operation of the Bacteriological Laboratory for Dairy Plants.
316. Electrical Statistics for California Farms.
317. Fertilizer Problems and Analysis of Soils in California.
318. Termites and Termite Damage.
319. Pasteurizing Milk for Calf Feeding.
320. Preservation of Fruits and Vegetables by Freezing Storage.
321. Treatment of Lime-induced Chlorosis with Iron Salts.
322. An Infectious Brain Disease of Horses and Mules (Encephalomyelitis).

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